Chapter 7
Geospatial Data Overview And Standards

7-1. General

Because of the diversity of applications and data collection efforts, USACE has never mandated a specific GIS or CADD vendor solution. USACE has instead focused on standardizing data and data life cycle management as a means to reach interoperability and manage it's investment in GIS technology. The cost of developing and maintaining geospatial data is by far the most expensive part of implementing geospatial technologies. Standardization and interoperabilty enable the data collected by District or field offices to be used throughout the organization in an Enterprise implementation and are the link to state, local, national and international agencies that are also collecting geospatial data.

Recent events have raised the level of concern over our national defense, and have created an overarching need for data in support of diverse applications, including for Homeland Defense. A direct result of this has been to extend the use of the data collected by USACE well beyond the boundaries they were envisioned for; the importance of the data's content, density, and quality have been greatly magnified. To compound this situation are improved capabilities in data collection and legacy/current applications that use the data, emerging technologies that will consume the data, and an ever-increasing demand for greater detail. The combination of these demands will continue to push the envelope for data needs, and in a variety of formats. Rather than mandate a specific GIS or CADD vendor solution, USACE has instead focused on standardizing data and data life cycle management to meet the many challenges today and tomorrow. This focus on standards and life cycle management enables interoperability and provides an effective tool for USACE to manage the investment made in CADD and GIS technologies. The cost of developing and maintaining geospatial data is the most expensive and crucial part of implementing geospatial strategies. Standardization will enable the data collected by District or field offices to be used throughout the organization in an Enterprise implementation. In addition, strict adherence to Federal, National, and International standards will extend their usefulness to state, local, national and international agencies. Strict compliance will also assure that the data these other agencies are collecting will be compatible, and interchangeable with our own data sets.

7-2. Importance of Geospatial Data Standards

The development of GDS is not static, but adaptive and flexible. Despite this seeming contradiction, consider the dizzying pace of technological advances, which continually push the frontiers of data collection, the speed and accuracy of analyses, and output designs and displays. All of this adds to an enhanced ability to process greater volumes of shared data and enables a much larger audience to interpret and understand the data, whether for geospatial or other uses. Without a standard against which developers build their hardware or software, or collect data, there would exist a world of chaos and inefficiency, of a multitude of single use applications and data, and a wholesale increase in cost to manage programs. Duplication of efforts would be rampant. Additionally, to keep the standard current and relevant, it must be refreshed regularly in anticipation of emerging technologies. The maturation of geospatial technologies has resulted in the potential for wide use by many organizations. Standards therefore provide interoperability and flexibility, which allows users to adapt the standards to their specific environment. This flexibility should be used with caution, however, to avoid distortion of the standards intent.

a. Benefits of geospatial data standards. The adoption of standards provides a multitude of benefits, such as the following:

- *Removal of barriers* - standards enhance geospatial data exchange and sharing. The exchange mechanisms for the transfer of geospatial data between dissimilar systems are addressed by standards.

- *Improvement in data quality and configuration management* - standards provide metadata to help organize and maintain the organizations internal spatial data.

- *Increased user confidence* – standards provide confidence in the quality of the data, and define the data's structure and content.

- *Greater access to geospatial data* – standards widen the spectrum of available data that results in a broad range of choices available to the user community.

- *Integration of systems* – standards enables the use of data across a wider spectrum of applications, thus maximizing effective the use of systems.

- *Data collection* – standards reduce duplication and overall costs of geospatial data collections.

- *Greater Public access* – standards of geospatial data extend their use in the public sector, and there is an increase in the GD&S user base due to data availability with an attendant diffusion of knowledge.

b. *Types of geospatial data standards.* Standards may be catalogued in several ways. In most cases, standards are either developed in an informal or formal process, in reaction to, or in anticipation of need. An informal process is one developed by source of authority. An informal standard, or de facto standard, is exemplified by AutoCAD DXF. In this case the user community, through constant use, adopts a practice without any formal certification. A formal process to develop standards includes certification by a government body or a professional organization. Types of geospatial data standards involve:

- *Data modeling* – either a conceptual or logical description of data organization

- *Data content* – a definition of feature, attribute, and values

- *Data symbology* – specifies display and output symbol libraries

- *Data quality reporting* – provides a standard for dataset quality reporting

- *Metadata* – data that describes the dataset and includes information on its usage

- *Data exchange and transfer* – standards which define how data is exchanged or converted from one format to another

There are a number of organizations who are involved with the formal process of developing standards. A hierarchy of these organizations exists and is shown in the following table:

Level	Organization	Web Site
International	International Organization for Standardization (ISO)	www.iso.ch/iso/en/ISOOnline.frontpage

	ISO Technical Committee for Geogrpahic Information/Geomatics (TC211)	www.isotc211.org/
	Open GIS Consortium	www.opengis.org/
	InterNational Committee for Information Technology Standards (INCITS)	www.incits.org/geninfo.htm
	International Hydrographic Organization (IHO)	www.iho.shom.fr/iho.html
	Information Working Group (DGIWG)	www.digest.org/About2.htm
National	Americian National Standards Institute (ANSI)	www.ansi.org/default.asp
	National Committee for Information Technology Standards (NCITS L1) Geogrpahic Information Systems	www.ncits.org/tc_home/l1.htm
Federal	Federal Gographic Data Committee (FGDC)	fgdc.gov/index.html
	FGDC Standards Working Group	www.fgdc.gov/standards/organization/swg_organization.html
	CADD/GIS Technology Center	tsc.wes.army.mil/

The above table is not exhaustive, but is illustrative of the many organizations that are formally engaged in establishing standards.

Another way to catalog standards is by the functionality that the standard addresses. For the GD&S area these form a framework of standards as seen below:

- *Hardware and Physical Connection Standards* - These are standards that pertain to the physical connection and cabling of hardware devices.
- *Application Standards* - These are standards that impact the actual presentation and display of data in a GD&S, such as map design criteria.
- *Software Standards* - These are standards that address the development of software and software documentation including macros.

- *Professional Standards* - These are standards that establish levels of competency and training.

- *Network Communication Standards* - These are standards that address the protocols for the transfer of data and information from one computer system to another

- *Data Standards* - These are standards that address geospatial data transfer formats, accuracy, documentation, structure, content and management. It is these standards that are discussed below.

7-3. Geospatial Data Components and Applicable Standards

It is not the intent to describe in detail geospatial data. There are numerous books and published reference materials on geospatial data. It is the intent of this section, to describe geospatial data and identify applicable standards.

An entity or feature is a real world phenomenon; such as a lake, river, house, etc. It can be modeled as a point, polygon, line, raster; but it is the thing being described. Entities, features; and geospatial data in general, can be broken into three parts: the spatial component, the attribute component and the metadata.

a. Spatial Component. All geospatial data has a spatial component or locational information associated with it. Locational information can take the form of latitude/longitude, state plane coordinates, Universal Transverse Mercator Coordinates, etc., but in order for it to be integrated with other data sets, it must have locational information tied to a geographic system. Survey data tied to local coordinate not tied to a geographic system can not be integrated into a GIS and are of use only for a specific task within a project. In order for As Built CADD data to be of use in a Enterprise GIS, the data need to be reference to a geographic coordinate system. Today's software, enables relatively easy conversion from one geographic coordinate system to another, but the data must be referenced to a geographic coordinate system.

Datums. To register and integrate different data sets, they need to be on the same datum and coordinate system. North American Horizontal Datum 1983 (NAD83) and North American Vertical Datum 1988 (NAVD88) are the preferred datums for collecting geospatial data in USACE. The National Geodetic Survey (NGS) maintains NAD83 and NAVD88 and most state and federal field offices have moved geospatial data collections to these datums. If other datums are being used, be aware that it will be difficult to integrate local data with regional or national efforts and NGS does not maintain older datums.

Scale and resolution issues. The scale of digital data can be manipulated easily; however, the scale should not be made larger than the collection scale. For example, digital data generated from a 1:20,000 base should not be used for large scale analysis. Increasing the scale/resolution of the collection scale and using it for analysis, introduces spatial error into the analysis.

Spatial Accuracy. Spatial or positional accuracy refers to the accuracy of the location information. Horizontal accuracy is an estimate of the x, y positions of spatial objects. For example, "95% of the well locations are within 50 meters of their surveyed locations." Vertical accuracy is an estimate of the z positions of the spatial readings. For example, "95% of the elevation points are within + or – 1 meter". Most accuracy standards dealing with digital geospaital data have evolved from hardcopy map accuracy standards or photogrammetric standards and are being applied to digital data.

The Federal Geographic Data Committee (FGDC) has endorsed a data accuracy standard consisting of 5 parts. The Geospatial Positioning Accuracy Standard Part 3: National Standard for Spatial Data Accuracy and The Geospatial Positioning Accuracy Standard Part 4: Standards for A/E/C and Facility Management

are directly related to USACE geospatial databases. Part 3 addresses accuracy of data smaller than 1:20,000 and Part 4 addresses accuracy of data larger than 1:20,000. In addition to Parts 3 and 4, Chapter 2 of the Photogrammetric Manual, EM 1110-1-1000, and Chapter 3 of the Hydrographic Surveying Manual, EM 1110-2-1003, outline USACE accuracy requirements. Appendix K gives detail of USACE accuracy requirements.

b. Attribute Component. The attribute component or the non-graphical component of the geospaital data, is the information about the geographic phenomena. For example, the information associated with a lake; such as, the name of the lake, volume, discharge rate, etc are all attribute information. Without the attribute information, the ability to perform spatial analysis is limited to automated mapping.

Uncertainty and data quality

Management of information. Developing a database schema (database entity/attribute structure) is a continual process. The more data that is geospatially referenced and integrated into a GIS the more data is seen as needing to be GIS enabled. In an attempt manage this data corporately and alleviate the expense of each District or functional area developing their own database schema, USACE has developed through the CADD/GIS Center for Facilities Infrastructure and Environment the Spatial Data Standards for Facilities Infrastructure and the Environment (SDSFIE).

The SDSFIE. The SDSFIE are a set of data standards that define the content of the database. They are endorsed by ANSI and are an implementation of FGDC content standards. The SDSFIE are a physical model and work with ESRI and Intergraph products. They provide a structure of the data model as well as mechanisms to transfer the data from one system to another. The SDSFIE are critical in developing an Enterprise GIS at District and Project Offices.

The SDSFIE are most useful when used with an external database; such as Oracle, Informix or Access. If the Command has not implemented an external database structure, the SDSFIE should be used as a data dictionary. SDSFIE compliancy is described in Appendix J. The SDSFIE are updated annually with comments from users and with new information from other standards organizations. Tools are provided with each release to upgrade user databases. The SDSFIE and tools can be downloaded from http://tsc.wes.army.mil.

c. Metadata Component. Geospatial metadata refers to the documentation of geospatial data sets. Geospatial metadata describes the content, quality, condition, and other characteristics of data.

Types of metadata. Geospatial metadata can be categorized into 3 cateogories.

1) FGDC Metadata. The Content Standard for Digital Geospatial Metadata (version 2.0) or FGDC Metadata is the complete documentation of a data set to enable the data to be used and reused. Documenting Geospatial data with FGDC Metadata is a requirement of EO 12906 and USACE is questioned about Metadata production during the OMB budget process. Chapt 8 provides details on documenting datasets with FGDC Metadata. General references to metadata in this manual imply FGDC Metadata.

2) Management Metadata. Management Metadata refers to a core set of elements for cataloging geospatial data. There are numerous COTS software packages/modules that address managing geospatial data. Management Metadata are what is required by these COTS software in order to effectively and efficiently catalog and manage geospatial data within an organization. At this time, there are no

mandatory or required standard for management metadata. Some have implemented the Dublin Core Metadata for management purposes.

3) Feature Level Metadata. Feature Level Metadata refers to collection information about an individual feature or object. Feature level metadata enables data sets to be merged without losing important collection information. For example, collection characteristics (such as, collection date) associated with hydrographic soundings are critical information and the association with the sounding needs to be kept intact when merging it with other data sets. There are no mandatory feature level metadata standards at this time; however, the Inland Electronic Navigation Chart (IENC) program will be establishing/identifying mandatory feature level metadata for hydrogrpahic surveying.

FGDC Metadata Resolution. Metadata resolution refers to the amount of metadata files are needed to describe a data set. There are no standard rules for how much metadata is needed to define data. Metadata resolution is driven by the dataset. A dataset of arial photography may only require one metadata file to define it adequately. If the photography was flown over multiple geographic areas at different times, multiple metadata files are probably required to adequately describe the data set.

Benefits of Metadata. The benefits of metadata are:

- Organize and maintain and organization's internal investment in spatial data
- Enables the reuse of data
- Provide information about an organization's data holding to data catalogues, clearinghouses and brokerages
- Provide information to process and interpret data received through transfer from an external source

7-4. Authority for Geospatial Data Standards

Standards for geospatial data in USACE are governed by the following organizations.

a. InterNational Committee for Information Technology Standards (INCITS). INCITS's mission is to produce market-driven, voluntary consensus standards in the area of Information Technology. The work of INCITS L1 Committee consists of adopting or adapting information technology standards and developing digital geographic data standards. INCITS L1 technical committee is the US TAG to ISO/TC 211, which is the ISO committee chartered to develop international geospaital data standards. ERDC represents USACE on this committee.

b. Open GIS Constorium (OGC). OGC is an international industry consortium of more than 220 companies, government agencies and universities participating in a consensus process to develop publicly available geoprocessing specifications. Open interfaces and protocols defined by OpenGIS® Specifications support interoperable solutions that "geo-enable" the Web, wireless and location-based services, and mainstream IT, and empower technology developers to make complex spatial information and services accessible and useful with all kinds of applications. ERDC represent USACE in OGC.

c. Federal Geographic Data Committee (FGDC). OMB Circular A-16 (Coordination of Surveying, Mapping and Related Spatial Data Activities) establishes a process to foster the development of a national spatial data framework for an information-based society with the participation of Federal, state, and local governments, and the private sector, and to reduce duplication of effort. It addresses the responsibilities of Federal agencies in the coordination of surveying, mapping, and related spatial data. It also establishes an interagency coordinating committee known as the Federal Geographic Data Committee (FGDC). The objective of the

FGDC is to promote the coordinated development, use, sharing, and dissemination of surveying, mapping, and related geospatial data.

Executive Order 12906 Coordinating Geographic Data Acquisition and Access: The National Spatial Data Infrastructure (NSDI) states, among other things, that Federal agencies collecting or producing geospatial data shall ensure that data will be collected in a manner that meets all relevant standards adopted through the FGDC process. It also establishes the FGDC's authority over the NSDI and the National Geospatial Data Clearinghouse(Clearinghouse).

d. *The CADD/GIS Technology Center for Facilities, Infrastructure and the Environment.* The CADD/GIS Technology Center is a multi- service vehicle to set standards and coordinate facilities CADD and GIS within the Department of Defense. The CADD/GIS Technology Center organization (Board of Directors, Corporate Staff, Field Working Groups, Staff) are the FGDC Facilities Working Group. The CADD/GIS Center develops and maintains the Spatial Data Standards for Facilities, Infrastructure and Environment (SDSFIE), the AEC CADD Standards and the Facility Management Standards. The SDSFIE were the basis for NCITS 353 and the annual release of the SDSFIE is coordinated with the NCITS 353 annual update.

7-5. Mandatory Standards

Standardizing geospatial data impacts the entire USACE organization. HQUSACE only mandates geospatial data standards that are mandated by a higher authority, sufficiently mature, and will benefit the overall organization. ER 1110-1-8156, paragraph 6 requires that anyone who believes mandated standards are inappropriate for their use must apply to CECW-EE for a waiver. The waiver must explain why the standards are inappropriate and what will be used instead. Recommended standards are those where compliance is encouraged but the maturity of the standard is not sufficient for them to be mandatory. Below are the mandatory geospatial data standards to be used in USACE.

a. Content Standards for Digital Geospatial Metadata. This standard specifies the information content of metadata for a set of digital geospatial data. The purpose of the standard is to provide a common set of terminology and definitions for concepts related to these metadata. This standard is the data documentation standard referenced in Executive Order 12906 which mandates the documentation of all new geospatial data starting 11 January 1995 and the development of a plan to document geospatial data previously collected or produced, by 11 April 1995.

The metadata standard is the product of the FGDC. Executive Order 12906 instructs Federal agencies to use the metadata standard to document new geospatial data beginning in 1995 and to provide these metadata to the public through the National Geospatial Data Clearinghouse. There are numerous tools available (both commercial, in the public domain, and associated with specific vendor products) to generate metadata. The FGDC keeps a list of those available on the internet at http://www.fgdc.gov/metadata/metatool.html CorpsMet is a metadata generation tool developed by USACE. It is available at http://corpsgeo1.usace.army.mil.
Under NO circumstances should metadata be generated using a wordprocessing software or text package. It must be generated using a metadata generation software tool.

b. *Spatial Data Standards for Facilities, Infrastructure and Environment (SDSFIE)* These standards are applicable to all Department of Defense activities having civil works or public works, military programs, and environmental programs or that are responsible for facilities/installation management that do not use a raster model. They prescribe standards and specifications for GIS vector and object modeled data. The intent is to create standards that will satisfy the project life-cycle concept for digital data There are many subcommittees and working groups of the FGDC that are development of content standards and the work is at various levels of maturity. The final versions of these standards are incorporated into the SDSFIE for distribution and use

throughout USACE therefore by using the most recent version of the SDSFIE one will also be using the most recent FGDC content standards.

c. USACE Interim Standards and Specifications for Surveys, Maps, Engineering Drawings, and Related Spatial Data Products. – I have no idea what this is! This is to be used for prescribing standards and specifications for USACE field surveys, maps, engineering drawings, and related spatial data products. It is applicable to all HQUSACE elements, major subordinate commands, districts, laboratories, and field operating activities having civil works, military programs, and environmental restoration responsibilities. It also applies to functional areas having responsibilities for regulatory investigations and studies, real estate, and support to Army installation master planning, and other functions involving surveying, mapping, or spatial database development.

7-6. Data Policies and Coordination

a. Policies. Each USACE Command may develop tailored GD&S policies to supplement and implement this guidance document. Tailored policies regarding GD&S technologies shall be drafted by the GeoPMT and approved by the Command's Senior Leaders. Tailored policies shall adhere to the requirements of this document and all applicable standards, orders, and OMB circulars, and they shall support the goals of the NSDI.

b. Coordination of GD&S efforts. Coordination and prioritization of geospatial data acquisition and GD&S development efforts within a USACE Command shall be the function of the GeoPMT.

b. Coordination with authorities. The Command's GeoPMT shall appoint a representative to coordinate USACE geospatial data acquisition and GD&S development efforts with local and state governments and national GIS coordinating committees. This representative may be the Command Geospatial Manager or another member of the GeoPMT. If it is necessary, multiple members of this committee can liaise outside of the Command; however, information exchange then becomes critical. The purpose of the coordination is to reduce duplicative data collection efforts and identify cost sharing opportunities.

7-7. Required Elements

1) All geospatial data shall be documented using the FGDC or ISO Metadata Content Standard (See Section 7-5a)
2) All non-raster geospatial data shall be collected using the SDSFIE (See Section 7-5b)
3) All CADD data collection shall use the AEC CADD standard (See Section 7-6c)